FIRST SEMIANNUAL REPORT OF THE INSTITUTE FOR SPACE BIOSCIENCES AT FLORIDA STATE UNIVERSITY

15 March 1962

History

The institute was officially initiated on 1 November 1961. Its support derives predominantly from the National Aeronautics and Space Administration under Grant No. NsG-173-62. The institute is also supported by grants from The National Science Foundation, The U. S. Public Health Service, The General Foods Corporation, and The Eli Lilly Company. It is an integral part of The Florida State University.

Objectives

The objective of the institute is the investigation of processes involved in the origin, evolution, and development of organisms under terrestrial and extraterrestrial conditions. The emphasis is on comparative biochemistry and other aspects of comparative biology in the universe.

Personnel

The personnel of the institute consist of:

S. W. Fox, Ph.D., professor and director, molecular evolutionist

S. L. Hess, Ph.D., professor, comparative meteorologist

C. B. Metz, Ph.D., professor, experimental embryologist

K. Harada, Ph.D., research associate, organic chemist

T. Hayakawa, university diploma, research associate, polyamino acid chemist, lecturer, Kanazawa Univ.

A. Shivers, Ph.D., research associate, U. S. P. H. S. fellow, experimental embryologist

B. Wiggert, M.S., research associate, chemist

S. Yuyama, B.S., research associate, cell biologist

Personnel cont'd.

J. G. Joern, M.S., graduate student (assigned by Air Force)

J. Branham, M.S., graduate assistant

T. Evans, B.A., graduate assistant

L. Franklin, M. S., graduate assistant

C. Genaux, M.S., graduate assistant

P. D. Hoagland, M.S., graduate assistant

D. L. Rohlfing, M.S., graduate assistant

L. Rustad, B.S., graduate student

A. Schwartz, M.S., graduate assistant

K. K. Stewart, B. A., graduate assistant

R. Cheng, technical assistant

W. H. Cox, technical assistant

J. Inward, technical assistant

C. R. Windsor, B.S., laboratory assistant

N. Smith, machinist

H. Hendry, executive assistant

L. Roddenberry, administrative assistant

M. Franklin, executive secretary

A. B. Kinney, secretary

P. McAleavy, secretary

E. R. Grant, undergraduate assistant

S. Porco, part-time stockroom assistant

F. J. Rowe, part-time stockroom assistant

R. J. Savoy, part-time stockroom assistant

B. Smith, undergraduate assistant

S. Sportelli, half-time stockroom clerk

Equipment

Much of the first period was spent in acquisition of personnel and equipment.

Major items consisted of fractionating columns, machine shop items for models of planetary atmospheres, time-lapse microscope equipment, Perkin-Elmer Infracord, Titrigraph, Wilkens Aerograph, LKB Ultramicrotome, and a Harris International Cryostat.

Working Space

The institute occupies 3100 square feet in the Conradi Building and approximately 2000 square feet in the new Mathematics-Meteorology Building. About 280 square feet of space is new since the inception of the institute. Some of the space in the Mathematics-Meteorology Building is occupied by Dr. Takashi Ichiye who is building a model ocean under a National Science Foundation grant. Dr. Ichiye is one of the participants in the ISBS; his work supports that of Dr. Hess. Negotiations are under way to provide additional working space for at least one more faculty member.

RESEARCH PROGRESS

From the Laboratory of S. W. Fox

Work in this laboratory on possible modes of origin of biochemical substances and organization have involved continuation of studies of formation of proteinoids. These materials are produced by thermal copolymerization of dry amino acids containing a sufficient proportion of aspartic acid or lysine. The copolymers contain all of the amino acids commonly found in protein and have mean molecular weights within the range of weights of protein molecules. (Many methods are known for the production of amino acids under presumed prebiological conditions). The proteinoids are found to have many more characteristics of proteins, including susceptibility to proteolytic enzymes, nutritive quality for bacteria, and in general they can be studied as potentially akin to primitive proteins.

The proteinoids, as derivatives of histidine, are catalysts for the hydrolysis of p-nitrophenyl acetate, with some preparations fifteen times as active as free histidine. In contrast to the behavior of histidine and of a simple derivative, the catalytic activity is destroyed by heat at 100° at pH 6.8 for 20 minutes.

When the proteinoid in decigram amounts is heated in water at pH 2.5 - 3.0, there result on cooling typically billions of microspheres of the size and shape of the cocci and with several properties of true cells. These precell models are alternative to the coacervate droplets of A. I. Oparin. The microspheres can be centrifuged like bacteria, in contrast to the coacervate droplets which coalesce on centrifugation. The microspheres arise under circumstances suggesting primordial events in contrast to such proteins as gelatin used in coacervates, gelatin being of late evolutionary origin. The proteinoids are also subject to

almost limitless variety in synthesis, and the microspheres are often of such uniform size as to permit quantitative experiments.

Hundreds of variations of the polymerizations and spherulizations have been performed. On the basis of this experience, it is possible to infer that these processes are so inexorable over such a range of conditions that these processes must have occurred on many occasions in many locations in the universe.

These experiments and emphases lead to the interpretation that formed elements found in carbonaceous chondrites may be (1) formerly alive, (2) purely physical artifacts, (3) preliving forms. This broader point of view, supported by varied photomicrographs, was advanced at the Denver meeting of the AAAS. Cooperative studies with Dr. Claus of N.Y.U. have begun as a result. This larger outlook, as expressed above and in Denver, has been published by P. Morrison in Science 135, 863 (1962).

Cooperative work on proteinoid is under way with Dr. G. Krampitz and Dr. F. Knappen of the University of Bonn. These workers are feeding to rats 400 g. of proteinoid prepared in this laboratory by Dr. H. A. Campbell of the General Foods Corporation.

Cooperative work in microspheres is under way with Dr. Jerome Wolken of the University of Pittsburgh who, during a four-day visit to this institute, established that chlorophyll could be incorporated with the microspheres. Cooperative work is also under way with Dr. R. S. Young and his associates at the Ames Research Center. Dr. Young has found many new properties in the microspheres.

A device for the sampling and analysis of extraterrestrial macromolecules is under investigation.

From the Laboratory of S. L. Hess

A theoretical investigation of the vertical structure of the atmosphere of Venus is being carried out by Hess and Joern. The goal is to calculate the radiative equilibrium lapse rate of temperature with elevation above the visible cloud surface. The primary absorber and radiator of infrared energy in the Venus atmosphere is CO_2, of which there is present approximately 1,000 meter-atmospheres. Mintz at U.C.L.A. has already performed a crude analysis of this sort with interesting results. Hess and Joern intend to deal with the several bands of CO_2 in a more detailed fashion than did Mintz and to take into account the pressure dependence of the absorption coefficients. The computations will be performed on the University's IBM 709 computer and will be based on both the empirical and theoretical studies of the absorption coefficients of CO_2.

Materials have been procured and others are on order to construct a rotating model for the simulation of planetary atmospheric flow patterns. When completed, this apparatus will be used, first, to attempt to simulate the well known and unusual circulation of the atmosphere of Jupiter.

A laboratory model of instrumentation to be dropped into the atmosphere of Mars has been designed and is under construction. This apparatus is theoretically capable of measuring pressure, temperature, and frost-point temperature to a satisfactory degree of precision and is also amenable to miniaturization to meet stringent restrictions on rocket payloads. The primary goal is to determine the accuracy and response time of the frost-point measurements by laboratory tests.

From the Laboratory of C. B. Metz

To a considerable extent, this has been a period of "tooling up" for application of new methodologies to problems being investigated. The research activities during the period have concerned two main avenues. One of these involved efforts to examine for effects of weightlessness on fertilization and cleavage of sea urchin eggs. The experiments were attempted in collaboration with Dr. R. S. Young of the Ames Laboratory using Bios I. Although neither of the nose cones were recovered, valuable experience was gained by both the scientific group and the launch and assembly crews. In every attempt to perform this experiment - the two Jupiter shots (18 and 23) as well as Bios I and Bios I backup - the count-down schedule for loading was such that conditions of temperature and aging of the material were marginal at best. It is our hope that we have succeeded in convincing the engineering group that a new Bios nose cone needs to have a retractable panel similar to the Bios nuclear emulsion carrier, or some other arrangement, into which freshly prepared biological capsules can be inserted just moments before launching.

The second research program concerns immunochemical studies on fertilization mechanisms in the frog and sea urchin. The former study is being carried on by Dr. Shivers. He finds that papain digested (univalent) anti-egg jelly serum markedly inhibits the fertilizability of frog eggs just as does the undigested antibody. This observation combined with a demonstration of antigen precipitation inhibiting activity in Ouchterlony tests strongly supports the view that the fertilization inhibiting action in this instance results from direct blocking of receptor sites that perform a significant role in fertilization. In related work, Dr. Shivers has succeeded in fluorescein labelling of antifrog egg sera and localizing egg jelly antigens in the frog oviduct using frozen sections and fluorescence microscopy.

Work of Others

The progress of Dr. Ichiye on models of oceans is mentioned under Working Space.

Research by Dr. Sherwood Reichard on antiradiation extracts from the rat is supported in its initial stages by the institute.

An offer was made to Professor Colin Barrow to purchase for his program urgently needed additions to his radioastronomy setup in Tallahassee. New non-life science funds, however, came through promptly following this offer and telephone conversations.

Professor Barrow has established a radio observatory close to the campus and has begun a program of observations of Jupiter. Polarized radio bursts have been recorded and will constitute a main emphasis in future studies.

PUBLICATIONS AND PRINCIPAL PRESENTATIONS

J. Branham and C. B. Metz: Inhibition of Fertilizin Agglutination and Fertilization in Arbacia by Fucus Extracts. Biol. Bulletin, in press.

S. W. Fox and K. Harada: Synthesis of Uracil under Conditions of a Thermal Model of Prebiological Chemistry. Science 133, 1923 (1961).

S. W. Fox, K. Harada, and D. L. Rohlfing: The Thermal Copolymerization of α-Amino Acids, in the First International Symposium on Polyamino Acids, University of Wisconsin Press, in press.

S. W. Fox and K. Harada: Experiments Related to the Chemical Origins of Protein, in volume of The Nassau Conference on Medical and Biological Problems of Space Flight, Academic Press, in press.

S. W. Fox and S. Yuyama: Borders of the Evolutionary Variation in Protein Molecules, presented in the Symposium on Extraterrestrial Biochemistry and Biology, Denver, 27 December 1961. The first paper reporting the relationship of this work to meteorite analysis is by P. Morrison, Science 135, 663 (1962). See also P. E. Cloud, Jr. and P. H. Abelson, Proc. Nat'l. Acad. Sci. U.S.A., 47, 1705 (1961).

S. W. Fox with P. A. Abelson: "Chemical Origins of Life," Washington section of the American Chemical Society, 9, November, 1961.

S. W. Fox, "Experiments Related to the Origin of Life", Fairchild Tropical Garden lecture, 10 February 1962.

S. L. Hess: Mars as an Astronautical Objective in Space Science and Technology, vol. 3 (1961).

(S. L. Hess has prepared also an unpublished mimeographed paper entitled, "A Method for Determining the Composition of the Martian Atmosphere by Indirect Measurements from Mariner B.")

C. B. Metz and H. Schuel: Inhibition of Agglutinability and Fertilizing Capacity of Sea Urchin Sperm by Papain Digested Antibody. Amer. Zoologist 1, 463 (1961).

C. B. Metz: Fertilization Reprint of Forum Lecture for Voice of America.

C. B. Metz: Fertilization Studies Using Inhibitions. Proc. Congr. Intern. Inst. Embryol. (Pallanza), in press.

C. A. Shivers: Studies of the Effect of Homologous and Heterologous Antijelly Sera on Fertilization of Eggs of Rana Pipiens. Amer. Zoologist 1, 186 (1961).

VISITORS

1 November 1961 - 15 March 1962

Dr. Dorothy Pitelka (University of Calif. at Berkeley)

Dr. Philip Abelson (Carnegie Institution)

Dr. Halvor Christensen (University of Michigan)

Dr. Jerome Wolken (University of Pittsburgh

Dr. David Tyler (National Science Foundation)

Dr. D. I. Packham (United Kingdom Scientific Mission)

Dr. G. E. Fogg (University College, London)

Dr. Webb Haymaker (Ames Research Center)

Dr. Julius Marmur (Brandeis University)

Dr. George Wald (Harvard University)

Dr. Ray Heinmets (The Quartermaster Corps)

The expenses of the first four were borne by the institute; each contributed to the program of the institute, with visits of one to four days. Others (Drs. Marmur, Wald, and Heinmets) were guests of the Institute for Molecular Biophysics.

MISCELLANEOUS

Dr. Hess has inaugurated a graduate course in planetary atmospheres.

ALLIGATOR HARBOR MARINE LABORATORY

Contribution to support has taken the form of salary for administrative assistant to Dr. Metz, and supplementation of salary of laboratory superintendent.